Claims and Support

App'n Claim 17	Support
17. A method for determining a volume of formation cut by each one of a plurality of roller cones on a drill bit drilling in earth formations, comprising:	"Designer can evaluate the force balance and energy balance conditions of existing bit designs." p.11 ll.8-9.
selecting bit design parameters, comprising at least a geometry of a cutting element on the drill bit; selecting an earth formation;	"... the volume of formation removed ... is calculated ... based on input data of bit geometry, rock properties, and operational parameters." p.20 ll.1-4 (emphasis added).
calculating from the selected bit design parameters and the selected earth formation, parameters for a crater formed when each one of a plurality of cutting elements on each of the roller cones contacts the earth formation, the parameters including at least a volume of the crater;	"If the tooth is in interaction with the hole bottom, the hole bottom is updated and the cutting depth for each cutting element is calculated...." p.14 ll.22-24. "...the volume of formation removed by each tooth in each row, of each cutting structure (cone), is calculated." p.19 l.27-p.20 l.2.
incrementally rotating the bit, and repeating the calculating of the crater parameters for a selected number of incremental rotations; and	"After the bit is fully drilled into the rock, these forces are recorded at each time step. A period time usually at least 10 seconds is simulated." p.14 l.29-p.15 l.2.
combining the volume of each crater formed by each of the cutting elements on each of the roller cones to determine the volume of formation cut by each of the roller cones.	"(a) calculating the volume of formation cut by each tooth on each cutting structure; (b) calculating the volume of formation cut by each cutting structure per revolution of the drill bit...." p.21 ll.21-23.

App'n Claim 18	Support
18. A method for balancing a volume of formation cut by each one of a plurality of roller cones on a drill bit drilling in earth formations, comprising:	"... the objective is to let each cone remove the same amount of rock in one bit revolution. This is called volume balance or energy balance." p.17 *ll*.4-6.
selecting bit design parameters, comprising at least a geometry of a cutting element on the drill bit;

selecting an earth formation; | "The first step in the optimization procedure is to choose the design variables." p.16 *ll*.20-21.
"... the volume of formation removed ... is calculated ... based on input data of bit geometry, rock properties, and operational parameters." p.20 *ll*.1-4 (emphasis added). |
calculating from the selected bit design parameters and the selected earth formation, parameters for a crater formed when each one of a plurality of cutting elements on each of the roller cones contacts the earth formation, the parameters including at least a volume of the crater;	"If the tooth is in interaction with the hole bottom, the hole bottom is updated and the cutting depth for each cutting element is calculated...." p.14 *ll*.22-24. "In the preferred embodiment ... the volume of formation removed by each tooth in each row, of each cutting structure (cone), is calculated." p.19 *l*.27-p.20 *l*.2.
incrementally rotating the bit, and repeating the calculating of the crater parameters for a selected number of incremental rotations;	"After the bit is fully drilled into the rock, these forces are recorded at each time step. A period time usually at least 10 seconds is simulated." p.14 *l*.29-p.15 *l*.2.
combining the volume of each crater formed by each of the cutting elements on each of the roller cones to determine the volume of formation cut by each of the roller cones; and	"(a) calculating the volume of formation cut by each tooth on each cutting structure; (b) calculating the volume of formation cut by each cutting structure per revolution of the drill bit....," p.21 *ll*.21-23.

App'n Claim 18	Support
adjusting at least one of the bit design paranieters [parameters], and repeating the calculating the crater volume, incrementally rotating and combining the volume until a difference between the combined volume cut by each of the cones is less than the combined volume determined prior to the adjusting the at least one of the bit design parameters.	"(d) adjusting at least one geometric parameter on the design of at least one cutting structure; and (e) repeating steps (a) through (d) until substantially the same volume of formation is cut by each of said cutting structures of said bit." p.22 ll.7-10. "The roller cone bit is energy balanced such that each of the cutting structures drill substantially equal volumes of formation." p.10 ll.17-18.